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## STRATIGRAPHIC NOMENCLATURE OF THE EARLY TERTIARY OF CENTRAL PATAGONIA<sup>1</sup>

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In the prosecution of research on the collections of the Scarritt Patagonian Expedition, it was at first intended to postpone discussion of stratigraphic nomenclature until the preparation and identification of specimens were complete and their full stratigraphic significance determined. In preliminary publications, in cataloging, and in manuscript for the definitive memoir, horizons have been indicated according to the biological names of Ameghino, *Notostylops* Beds, *Astraponotus* Beds, etc. As the work has progressed, however, this has become increasingly inconvenient and it has become apparent that the selection of some uniform nomenclatural system, definitive as far as it can be on present knowledge, is very desirable in order to obtain permanence of record and to avoid needless labor. This nomenclature is, furthermore, in an extremely confused condition, and a conservative attempt to sum up the synonymy of the literature and to give a basis for greater future uniformity must be useful.

The scope of this inquiry is the naming of the subdivisions of the terrestrial deposits of Tertiary age which underlie the great marine Patagonian formation in southern Chubut and northern Santa Cruz. Some older beds will be mentioned only so far as they bear on this problem.

In the first place it is clear that the series of strata so defined is complex and that its subdivisions, so far as now indubitably recognizable, should have distinctive and clearly defined names. As criteria for the selection or proposal of such names, the following seem to be in general accord with the soundest international usage:

1. New names should be proposed only when absolutely required.
2. Names should be applied to each stratigraphic entity which is definitely known on data faunal, lithologic, or structural to be a distinctive unit.
3. As opposed to names of epochs, étages, life-zones, and the like, names given to definite local formations and to their members should extend only to beds in complete or essential lateral continuity or to dis-

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<sup>1</sup>Publications of the Scarritt Patagonian Expedition, No. 18.

continuous beds which can be shown beyond any reasonable doubt to be both contemporaneous in time and similar in origin.

4. Again as opposed to some larger rock categories or some time categories, names of these definite local stratigraphic units should invariably be geographic and preferably taken from a name applied to a geographic feature at or near a good and typical development of the formation or member so named.

Ameghino 1906		Gaudry 1906	Windhausen 1924		Feruglio 1929
[Lower part of] Patagonienne	Colpodonéen	du Deseado	Tobas mamíferas  del Eogeno	Colpodonense	Capas con Colpodon
Guaranienne	Pyrotheréen			Pyrotheriense	Capas con Pyrotherium
	Astraponotéen	[Not dis- tinguished]		Notostylopense	Capas con Astraponotus
	Notostylopéen	de Casamayor			Capas con Notostylops
	Notostylopéen Basal	[Not dis- tinguished]	Estratos con Dinosaurios Sección Superior	Pehuenche	
	Salamanquéen	Magellanien	Salamanqueano	Salamanqueano	
	Pehuenchéen	[Upper part of] Guaranién	[Upper part of] Estratos con Dinosaurios Sección Inferior	[Upper part of] Chubutiano	

Fig. 1. Synonymy of names applied to the late Cretaceous and Eogene of Central Patagonia.

5. Non-geographic names for such units, and specifically those based on lithology or on the names of supposedly characteristic fossils, should be rejected.

6. Homonyms, that is, names essentially identical with others already used (in the same country or region) with a different meaning, should be rejected.

7. If a name previously proposed is to be given a more restricted meaning, it should be applied to a unit included under that name by its original author.

8. While priority is not invariably to be followed, the names adopted should in general be the oldest applicable without ambiguity.

9. Names should in general be retained with their original meaning as nearly as possible without ambiguity, but this should not be taken as

Kraglievich 1930		Frenguelli 1930			Simpson 1933
[Lower part of Santacruciana]	Trelewense	[Lower part of]  Patagonico	[Lower part of] Santacruziano	Colhuehua- piense	Colhué-Huapí
Deseadoana	Deseadense		Deseadiano	Deseadense	Deseado
	Mustersense			[No name given]	Musters
Casamayorana	Casamayo- rense			Casamayorens	Casamayor
	Colhuehua- piense				
[Not discussed]		[Upper part of]  Chubutico	[Part of]  Pehuenchiano	Sehuenense	Río Chico ----- ? -----
				Salamanquense	Salamanca
				Pehuenchense	[Upper part of] Chubut

Fig. 2. Synonymy of names applied to the late Cretaceous and Eocene of Central Patagonia.

an excuse for renaming a formation every time some slight modification of its limits is necessary.

These criteria are rather generally recognized, and in part quite obvious, but they have not been consistently applied to the sequence here discussed.

The various nomenclatural systems proposed for the Eocene of

central Patagonia are typified by Ameghino's final arrangement (1906), Gaudry's interpretation of Tournouër's data (Gaudry 1906), Windhausen's report of 1924, Feruglio's classification of 1929, Kraglievich's general scheme for all the Argentine mammalian faunas (1930), and Frenguelli's Patagonian nomenclature (1930). These are compared in the accompanying table, which does not represent the authors' ideas as to correlation, age, etc., but only the probable or clear synonymy of the names used by them for particular formations in this one region. In this selection I do not ignore nor mean to slight the valuable stratigraphic work of Groeber, Keidel, Loomis, Ramaccioni, Roth, Stappenbeck, Tapia, Wickmann, Wilckens, and many others. The limits of the present paper do not permit exhaustive discussion of the geologic problems involved, and it is confined to the selection of an adequate nomenclature with only such detail regarding stratigraphic questions as is absolutely necessary for this purpose.

The first step is to decide what subdivisions of the series may properly be named (or have older names recognized) at the present time. The two limiting marine horizons already have almost universally accepted and entirely correct names: Patagonia, Patagonian, Patagoniano, etc., for the mid-Tertiary overlying group, and Salamanca, Salamancan, Salamanqueano, etc., for the probably Senonian underlying group which contains purely marine beds but includes also coastal, estuarine, or even perhaps partly fresh-water strata. Directly beneath the Patagonian are the *Colpodon* Beds of Ameghino, a well defined unit certainly requiring a distinctive geographic name.<sup>1</sup> The next lower formation, *Pyrotherium* Beds of Ameghino, Deseado of Loomis and others, is likewise distinctive and already generally accepted as a nameable unit.

The next older fauna and corresponding stratigraphic subdivision named by Ameghino, his *Astraponotus* Beds, have been less generally recognized. Several authors (e.g., Gaudry, Frenguelli) simply ignore this zone. Others (e.g., Kraglievich) accept Ameghino's data without any restudy or critical evaluation. No one except the Ameghinos has published any original research consciously<sup>2</sup> involving this formation. The fauna and formation do exist. There is a very marked break between the *Notostylops* and *Pyrotherium* faunas of Ameghino, a break represented in the field either by a distinct erosional unconformity or by intervening strata which do in fact contain a recognizably distinctive and intermediate fauna. These strata are not yet well understood. The

<sup>1</sup>There is evidence, strong but not absolutely conclusive, that the so-called *Colpodon* Beds (Colhué-Huapi Formation) are contemporaneous with the lowest Patagonian. In any event, they constitute a distinctive formation, being of purely terrestrial origin, different in aspect and fauna from the possibly synchronous marine beds.

<sup>2</sup>Many of Roth's fossils apparently belong to this fauna, but he did not accept them as such.

boundaries have still to be exactly established. It is possible that Ameghino did not in every case correctly determine the exact faunal position of specimens from near the lower boundary. It is further possible that this fauna is itself to be subdivided into lesser faunules or facies. These problems for future research (some of them at least partly soluble from data now in my hands) do not alter the fact that Ameghino's *Astraponotus* Beds do exist, are distinctive, and require a name.

Finally, at the base of the sequence are Ameghino's *Notostylops* Beds. Ameghino believed these to include several different faunas and formations, saying, for instance (1906, p. 465), "En réalité ce n'est pas une faune sinon la succession de trois faunes, peut-être de quatre . . .," but (Ibid., p. 466), "pour le moment je crois convenable de les énumérer comme constituant dans leur ensemble une seule grande faune. . . ." He had previously (1902, p. 4) given lists of genera distinctive of a "Notostylopense superior" and of a "Notostylopense inferior," but his action of 1906 in uniting these into a single list tacitly recognizes the fact that this division, if not incorrect, was premature. It is probable that this formation can be zoned, but this has not yet been done, and the zoning suggested by Ameghino (previous to 1906) is not in fact recognizable and was more hypothetical than real. For the present, these beds must be considered and named as a unit.

Ameghino further mentioned the existence of a still lower unit, the "Notostylopense basal" (or Notostylopéen basal). His references to this are not wholly clear, but he seems in a general way to have included under this name those beds between the Salamanca and the mammal-bearing "Notostylopense" (=Casamayor), that is, the strata called Pehuenche by Feruglio and other more recent students, including the "argiles fissilaires" of Mazaredo and the similar beds south of Colhué-Huapí. The name "Notostylopense basal" was rather theoretical, for Ameghino gives no evidence that *Notostylops* itself occurs here, and in fact, so far as I recall, he did not positively state that any mammals were found in these beds. Nevertheless I believe that Ameghino's understanding of the nature of this sequence was much better than that of any later student to the present time, and extraordinary and largely unnecessary confusion has resulted from rejecting his views, or from the failure to understand them.<sup>1</sup>

<sup>1</sup>Too detailed an account of the many stratigraphic interpretations would be merely confusing in this summary paper, concerned primarily with nomenclature. One important point regarding this part of the section is that Ameghino believed that his lower and, or, basal *Notostylops* Beds were synchronous with the Salamanca. This is surely erroneous, but—and from failure to make such a distinction have arisen most of the misunderstanding and unjust criticism of Ameghino—it is not an error of observation. He well knew and made very clear that his whole "Notostylopense" invariably overlies the Salamanca when both are present at one locality. The error was in his interpretation of them as replacing each other laterally.

Without reviewing subsequent work in specific detail, as it became generally accepted that the "Notostylopense" and all overlying beds were of Tertiary age, this underlying formation was invariably placed in the Cretaceous and it was even maintained that there is a marked angular unconformity above it. For a characteristic expression of this school of thought, see Windhausen, 1924. Feruglio, 1929, questioned some of the detailed evidence for this division, but continued to accept it in general as valid. The detailed field observations will be published elsewhere, but, as already mentioned (Simpson, 1932), our work shows beyond serious doubt that the supposed angular unconformity here is illusory, that if (as is quite probable) an unconformity does exist, it was not marked by much if any local folding in this region and does not represent a long lapse of time, and that at least a large part of this series of strata belongs indubitably in the Tertiary. This series contains a mammalian fauna, unaccompanied by dinosaurs, related to but not identical with that of the overlying Casamayor, and surely of Tertiary age. It is, or includes, a Tertiary formation, distinctive lithologically and faunally, which also requires a name.

The units for which names are to be selected or proposed here are, then, five: the *Colpodon*, *Pyrotherium*, *Astraponotus*, *Notostylops*, and "basal *Notostylops*" Beds of Ameghino.

Another unit very distinctive lithologically is the so-called "argiles fissilaires" of Ameghino. These beds (actually silicified tuffs and bentonites) are typically developed below the "*Notostylops*" and "*Pyrotherium* Beds" (Casamayor and Deseado) at Cañadón Lobo (Cañadón Tournouër) and Punta Nava, and also occur in the valley of the Río Deseado, at various places in the whole region south of Lago Colhué-Huapí, and in several other localities in central Patagonia, similar in lithology and stratigraphic position. Some rather different strata have been tentatively considered as belonging in the same category (e.g., near Malaspina, by Fergulio, 1929). Ameghino did not consider these as forming a distinctive horizon, saying (1906, p. 103), "Ces argiles fissilaires ne constituent pas un horizon déterminé, car il y en a dans le pyrothéréen, dans le notostylopéen, dans le salamanquéen, dans le péhuenchéen, et aussi dans les grès bigarrés." Yet most subsequent work has confined the designation to their typical development, particularly as seen at Cañadón Lobo and south of Colhué-Huapí. These were both included, at least in large part, in the "Notostylopéen basal" by Ameghino, and by most subsequent writers have been placed in the Cretaceous, with the "estratos superiores con dinosaurios," "Pehuenche,"

etc.; indeed the mooted angular unconformity was supposed to be just above them. Only recently (Piatnitzky, 1931) has it been suggested that the "argiles fissilaires" may belong in the Tertiary tuff series. This anticipates publication of our own independent conclusion that the "argiles fissilaires" are surely of Tertiary age and probably are nothing more than local, partly metamorphosed tuffs of the thick ash and bentonite series, probably usually of Casamayor age. In any event, they do not at present require a distinctive name. No identifiable fossils have ever been found in them.

Many writers have proposed names or used locutions which include the first four of the five formations here discussed or two or three of them. Windhausen (1924) called them all the "tobas mamíferas del Eogeno,"<sup>1</sup> and others have similarly called them "tobas mamalíferas," and so on. These designations are perhaps useful descriptively, but they are not actual names of a geologic group or formation, and their vagueness makes them decidedly out of place in any detailed stratigraphic work. As yet the relationship between these formations and their various faunas is not clearly enough established for a grouping of all together or of any two or more to be other than a tentative measure, a practical expedient. For more detailed and accurate work, particularly from a paleontological point of view, this expedient is unnecessary and may be a real impediment to progress in our understanding of this quite complex and long sequence of formations. Such understanding has hardly progressed beyond the recognition of five smaller units, analysis of which must precede any definitive synthesis. These five smaller units, themselves of very considerable size, are now recognizable and nameable.<sup>2</sup>

<sup>1</sup>Cabrera (1927) has justly criticized the etymology of this phrase, pointing out that "tobas mamíferas" signifies "tobas que contienen o poseen mamas"—tuffs containing or having mammae—which is not what was really meant. He also criticizes the Spanish names formerly in very common use, "Notostylopense," "Astraponotense," etc. The termination -ense, Latin -ensis, is properly used only as an adjectival suffix after words of location. Casamayorensis is an etymologically correct Spanish vocable, but Notostylopense is not. The same error is occasionally made in forming neo-Latin specific names.

<sup>2</sup>Not as a criticism directed particularly at his valuable work, but because it typifies the attitude of those who consider all these beds as an indivisible unit, Frenguelli's opinion (1930, p. 56) may be quoted that "En los lugares fosilíferos, los restos de las faunas de *Notostylops*, *Astrapotherium* [*Astraponotus*? G.G.S.], y *Pyrotherium* se encuentran siempre desprendidos de su yacimiento y acumulados promiscuamente al pie de las barrancas. . . . No creo que los demás coleccionadores hayan podido hallarlos en condiciones diferentes, o por lo menos tales de poder ser utilizados como base seria de una clasificación estratigráfica." This almost casual brushing aside of the results of decades of careful, intelligent work seems to be a retrograde step in the study of the stratigraphy of this region. All work, from Ameghino's to our own, inevitably involves some error. Only by discerning, accepting, and augmenting the truth while correcting or rejecting the errors can progress be made. To reject a correct observation, because it was linked with an erroneous interpretation or for any other reason, is worse than accepting an error.

In this specific instance, we did find fossils in conditions "tales de poder ser utilizados como base seria de una clasificación estratigráfica," and so did Carlos Ameghino. In every section examined in detail we found identifiable guide fossils *in situ*. Of course specimens were also often found on the surface below their original horizons of burial, as is true in all paleontological collecting, and this necessitates some acumen and much care on the part of the collector. Some individual specimens or species were probably placed in the wrong zone by Ameghino and others, but our experience suggests that this was not frequent, and in any event the stratigraphic conclusions based on large collections are not vitiated by such errors in details.

Turning, then, to the names to be employed for the five terrestrial, lower Tertiary, mammal-bearing formations now recognizable, these may be taken up one by one, starting with the most recent, the so-called *Colpodon* Beds.

On June 9, 1899, Carlos Ameghino wrote to his brother suggesting the name "Colhuehuapense" for the highest mammal-bearing beds south of Lago Colhué-Huapi. The letter was published by Florentino Ameghino in 1900 (Ameghino 1903, p. 38—a separate edition of the same paper, previously published serially), but he did not adopt the name, calling this formation the "Colpodonense," "Colpodonéen," "Couches à *Colpodon*," etc. Almost all later authors have followed F. Ameghino. In 1908 (p. 102) Roth called the *Pyrotherium* Beds of Ameghino the "Colhuapi-Stufe." This was, essentially, giving the same name as Carlos Ameghino's to a wholly different formation.<sup>1</sup> So far as I know, no one has adopted Roth's name. In 1930 (p. 157) Kraglievich apparently overlooked the two previous uses of the name<sup>2</sup> and used it again with a third quite different meaning, calling the "Notostylopense inferior" of Ameghino the "Colhuehuapiense." At the same time Kraglievich proposed the new name "Trelewense" for the "Colpodonense" of F. Ameghino, a name unobjectionable in itself, but long antedated by the "Colhuehuapense" of Carlos Ameghino. Independently of Kraglievich and in the same year, Frenguelli (1930, p. 74) proposed to return to the name of C. Ameghino and to use "Colhuehuapiense" for the *Colpodon* Beds of F. Ameghino and others. This usage seems to me to be acceptable. The "Colhuapi-Stufe" of Roth and "Colhuehuapiense" of Kraglievich *non* Ameghino are to be rejected as homonyms. "Trelewense" of Kraglievich is rejected as a synonym of "Colhuehuapiense" of Ameghino *non* Kraglievich. The "*Colpodon* Beds" may be called the Colhué-Huapi Formation, Colhuehuapien in adjectival form, Colhuehuapiense in Spanish.

The next older faunal and stratigraphic unit was designated by Ameghino with names derived from the genus *Pyrotherium*. Gaudry (1906, p. 103) applied the name "*Étage du Deseado*" to the *Colpodon* and *Pyrotherium* Beds of Ameghino. Gaudry mentioned but did not accept the opinion that two distinct faunas occur. Nor, following

<sup>1</sup>Roth's "Colhuapi" must be recognized as the same geographic name as Ameghino's "Colhué-Huapi," although he spelled and used it differently. In my papers I use the spelling Colhué-Huapi, because it is that now common in the literature and officially sanctioned. I do not believe it to be etymologically correct. It is not a good approximation of the Indian (Araucanian, not Tehuelche) name (pronounced nearly as Colu-ouapi would be in French) nor of the present pronunciation of the Spanish-speaking colonists near the lake (variable but generally about like the Spanish pronunciation of Colhuapi or Coluapi).

<sup>2</sup>A very excusable oversight, as both were published rather casually and were not subsequently used.



Tournouër, did he recognize that both, and not merely the younger, are present at the "Gisement du Coli-Huapi." Loomis (1914) apparently did not recognize that the "Deseado" of Gaudry included both *Colpodon* and *Pyrotherium* Beds of Ameghino, for he stated that "Tournier" (i.e., Tournouër) and Gaudry had named the *Pyrotherium* Beds as the Deseado Formation. Although apparently unconscious, this redefinition by Loomis is valid and convenient and has been generally accepted. This formation may continue to be called Deseado, Deseadoan, or Deseadense.<sup>1</sup>

The *Astraponotus* Beds of Ameghino are happy in having little history. They have frequently been ignored altogether and when recognized this has been only by acceptance of Ameghino's views. So far as I know, the only geographic name ever applied to them is Mustersense of Kraglievich, 1930. This name may be accepted and this formation be called Musters (from the lake of that name), Mustersian, or Mustersense.

Of the three subdivisions of the "Notostylopense" suggested by Ameghino, Upper, Lower, and Basal, I believe that the first two should be included under one name, and the last given a different name. The formation which includes the upper and lower *Notostylops* Beds of Ameghino was named "Étage de Casamayor" by Gaudry, from Punta Casamayor. The designation is perhaps not the best that could have been made: the beds so named do not occur at Punta Casamayor but especially at Cañadón Tournouër of Ameghino, = Cañadón Lobo of the local inhabitants, a few miles from Casamayor, and so far as I can determine not one of Ameghino's scores of type specimens from this formation came from this locality or even this general region. But these considerations, not very serious in any case, only oppose the giving of such a name *de novo* and do not weigh against its acceptance once it is in wide use. The name Casamayor is already in general use for these beds and is the most satisfactorily established. It certainly should be accepted and the formation called Casamayor, Casamayorian, or Casamayorensis. Casamayorensis, it may be noted, is understood as used by Frenguelli, not by Kraglievich who confines it to the more or less hypothetically separated upper division and uses Casamayorana for the whole formation.

The nomenclatural situation regarding the beds between the Salamanca and the Casamayor is very unsatisfactory, reflecting, in part, the even less satisfactory knowledge of the stratigraphic and faunal rela-

<sup>1</sup>To the objections already expressed against the use of the broader names "Deseadoana" Kraglievich or "Deseadiano" Frenguelli, may be added that these are not, like Loomis' emendation, restricted and more exact definitions of Gaudry's term but applications of about the same breadth but of different content, including in each case more at the bottom and less at the top than did Gaudry—changes of rather doubtful value.

tions of these beds. This horizon was called "Notostylopéen basal" by Ameghino, at least in part, although he probably did not fully recognize its extent and nature and did not limit it in quite the same way as will be done here. Windhausen (1924) called these the "Estratos con dinosaurios, Sección superior," typical of several students who consider these strata, as a whole, to be merely the upper part of a Cretaceous terrestrial series locally and more or less incidentally cut off by a marine intercalation, the Salamanca. With much the same idea, Feruglio (1929) and others, especially the government geologists of the Dirección General de Yacimientos Petrolíferos Fiscales, called these beds the Pehuenche, and this has become the most usual name. Despite this common use, the name Pehuenche is certainly inapplicable to this series.

The very complex history of this name "Pehuenche" is not here wholly pertinent. It suffices to say that the name was proposed by Doering (1882), the type locality being Roca, in Río Negro, and along the banks of the Río Negro to the confluence of the Ríos Limay and Neuquén. As subsequently applied in this region, the name, if used at all, has come to be limited to a dinosaur-bearing series immediately underlying the marine Roca Formation, unquestionably of Cretaceous, and not latest Cretaceous, age. Ameghino extended this name to include also central Patagonian beds, which he considered synchronous with those to the north, immediately underlying the Salamanca, also of certainly Cretaceous age, Senonian or slightly earlier.<sup>1</sup> Essentially this same arrangement was followed by Stappenbeck (1909) with a broader use of the term Pehuenche, and still more recently Feruglio (e.g., 1929) and others have confined the name Pehuenche to the beds *above* the Salamanca Formation and below the Casamayor, as here understood. Now in the first place, actual correlation with the type Pehuenche has not been established, and the sequence is so different that there is some doubt whether the name Pehuenche should be used in central Patagonia at all. In the second place, even if the use of the name Pehuenche in this region be insisted upon, it obviously must be applied only to beds considered synchronous with the type Pehuenche, and it is demonstrably true that at least a large part of the beds so called, above the Salamanca, are not synchronous with the type Pehuenche.

This is recognized, in part, by Frenguelli (1930), who calls this series "Sehuenense." Unfortunately this involves another correlation equally

<sup>1</sup>It has been suggested that Ameghino was mistaken in thinking that his central Patagonian Pehuenche underlay the Salamanca. When later writers say that the Pehuenche *overlies* the Salamanca, they are merely making a different (and at least in part erroneous) correlation, and are applying the name Pehuenche in this region to beds definitely different from and younger than those so called by Ameghino.

uncertain. The type locality of the *Sehuenense*, named by Ameghino, is the Río Sehuen in southern Patagonia. These deposits remain very poorly known. It is probable, but not certain, that they are of late Cretaceous age. They are, *ipso facto*, probably not synchronous with all, and perhaps not with any, of the central Patagonian "*Sehuenense*" of Frenguelli. In any case the discontinuity of the two deposits, their apparently different conditions of deposition, and the lack of any truly established correlation between them make this use of the name inadvisable if not positively erroneous.

I believe that in places there is terrestrial Cretaceous overlying the Salamanca. This is not proven, and the delimitation of such a horizon, its correlation, and its naming require more definite data than now available. I know that much of the so-called "*Pehuenche*," "*Sehuenense*," "*Notostylopéen basal*," etc., below the Casamayor, is of Tertiary age, has never yielded a trace of dinosaurs and has yielded mammals at several localities over a wide area in southern Chubut. Lithologically these beds are very different from the overlying Casamayor. Faunally, also, there are differences, although as yet these are not exactly definable. These beds have never been given a correctly applicable name, and I therefore propose for them the name Río Chico (Río Chican, Río Chiquense) for the Río Chico del Chubut, in the valley of which these beds are developed. The Río Chico Formation is defined as a series chiefly composed of sandstones and clays (perhaps in part bentonite), immediately underlying the Casamayor Formation (ash and bentonite, little or no sandstone, with the typical "*Notostylops* fauna") and containing a fauna or faunal facies of mammals of Tertiary type, principally not ungulates, of very primitive character and small individual size. The Río Chico Formation overlies the Salamanca or its lateral equivalent, with or without the interposition of a post-Salamanca terrestrial series.<sup>1</sup> In physical character it is not always clearly distinguishable from part of the underlying terrestrial Cretaceous (pre- or post-Salamanca as the case may be) and may consist in part of material remanié from these older beds, but at least in places it tends to be of paler and less variegated color. Its mammalian fossils are generally found in gray sandstones which are rather distinctive. The fauna, which will be described later, appears to be closely related to that of the Casamayor, probably being directly ancestral to the latter, but to consist of distinctive and more primitive species or genera. It is probable that a few of the species

<sup>1</sup>The Salamanca itself grades vertically and laterally into beds of essentially fresh-water character and it is by no means clear that the beds properly included under this name are all marine.

described by Ameghino as from the "Notostylopense" were derived from the Riochiquense, which he included under the former designation without specifically recognizing that it contains a mammalian fauna.<sup>1</sup>

That part of the central Patagonian stratigraphic sequence here discussed may, then, be designated as follows (in order of superposition):

	Patagonia	} Perhaps partly overlapping in time.
	Colhué-Huapi	
TERTIARY	Deseado	
	Musters	
	Casamayor	
	Río Chico	
<hr/>		
CRETACEOUS		{ Possible late Cretaceous beds not yet clearly recognized or defined.
	Salamanca	

<sup>1</sup>Since our work, Feruglio (1931) and Piatnitzky (1931) have also announced the discovery (first made by Piatnitzky) of mammals in these beds. Feruglio continues to call the horizon "Pehuenche," and questions whether the "Pehuenche" is Tertiary or Cretaceous. There is no reason for considering the formation in which these mammals occur as other than Tertiary, but it is not, or cannot be called, the Pehuenche. Piatnitzky, on the other hand, distinguishes these mammal beds (without naming them) from the supposedly underlying "Pehuenche propiamente dicho," but believes them to be probably Cretaceous. From the nature of their fauna and other considerations this seems impossible to me. Fossils are scarce and not very well preserved, but we have enough to describe a typical fauna, to be published later.

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